5

10

20

What is claimed is:

- 1. An improved MRI system having a compact magnet and an RF coil which accommodate a human extremity such as a heel and external reference materials to measure the proton density of bone marrow to quantify trabecular bone volume fraction.
- 2. An improved MRI system as in claim 1 wherein said RF coil is stored in an electromagnetically shielded box to eliminate the electromagnetic coupling between the RF coil and gradient coil.
- 3. An improved MRI system as in claim 2 wherein said RF probe box has an oval aperture to accommodate a human extremity such as a heel.
- 4. An improved MRI system as in claim 2 wherein a support pad for a heel and external reference materials is inserted into said RF probe open-bore to fix the heel and to acquire calibration image data at the same time.
- 5. An improved MRI system as in claim 4 wherein said external reference material is flexible and can be used to fix a heel and to improve the precision of measurement of the RF magnetic field.
 - 6. An improved MRI system as in claim 1 wherein large flip angle spin-echo imaging sequences are used to shorten the repetition time of the sequences.
 - 7. A method for quantifying proton densities in inhomogeneous static magnetic field, magnetic field gradients, and RF magnetic field, comprising the step of:
- (a) measuring cross-sectional MR images of a human extremity such
 as a heel together with external reference materials with two
 spin-echo sequences in which the repetition time TR is long enough
 for signal saturation for the proton spins in the region of

20

25

10

interest and one spin-echo time is set as short as possible and the other spin-echo time is set longer than that of the shorter one by about 100ms to eliminate the J modulation effect on T2 decay correction;

- 5 dividing the image intensity of said MR image with the longer (b) spin-echo time by that of said MR image with the shorter spin-echo time to calculate T2 relaxation time and spin density distribution including the spatial variation function for the imaging area;
 - correcting the T2 decay by multiplying exponential function of the shorter spin-echo time divided by T_2 , by said MR image with the shorter spin-echo time;
 - (d) measuring cross-sectional MR images of a reference material such as paramagnetic salt doped water at the position where the human extremity was placed together with said external reference materials with two spin-echo sequences in which the repetition time TR is long enough for signal saturation for the proton spins and one spin-echo time is set as short as possible and the other spin-echo time is set longer than that of the shorter one by about T_2 relaxation time of the protons of the reference material to optimize the T2 decay correction;
 - dividing the image intensity of said MR image of the reference material with the longer spin-echo time by that of said MR image of the reference material with the shorter spin-echo time to calculate T_2 relaxation time and the spatial variation function for imaging area;
 - correcting the T2 decay by multiplying exponential function (f) of the shorter spin-echo time divided by T_2 , by said MR image of

the reference material with the shorter spin-echo time; and

- (g) dividing the T_2 corrected MR image calculated in (c) by the T_2 corrected MR image calculated in (f) to obtain the proton density of the human extremity such as a heel when the proton density of the reference material is defined as unity.
- 8. The method of claim 7, wherein the image intensity calculations are performed using means over some regions of interests to improve the data fluctuation.

10

5